

WHAT IS CLAIMED IS:

1. A semiconductor device having a wiring structure formed by a dual damascene method, the wiring structure comprising:

a lower buried-wiring layer;

an interlayer insulating film provided on the lower buried-wiring layer;

an inter-wiring insulating film provided on the interlayer insulating film; and

an upper buried-wiring layer buried in wiring grooves provided in the inter-wiring insulating film, the upper buried-wiring layer being electrically connected to the lower buried-wiring layer through contact plugs passing through the interlayer insulating film;

wherein the interlayer insulating film is a first carbon-containing silicon oxide film (SiOC film), and

the inter-wiring insulating film comprises a laminated insulating film including an organic or inorganic low dielectric constant insulating film, and a second carbon-containing silicon oxide film (SiOC film) provided on the low dielectric constant insulating film, the second carbon-containing silicon oxide film having a lower carbon content than that of the first carbon-containing silicon oxide film.

2. The semiconductor device according to claim 1, wherein the carbon content of the second carbon-containing silicon oxide film is 3 atomic % to 9 atomic %.

3. A semiconductor device having a wiring structure formed by a dual damascene method, the wiring structure comprising:

a lower buried-wiring layer;

an interlayer insulating film provided on the lower buried-wiring layer;

an inter-wiring insulating film provided on the interlayer insulating film; and

an upper buried-wiring layer buried in wiring grooves provided in the inter-wiring insulating film, the upper buried-wiring layer being electrically connected to the lower buried-wiring layer through contact plugs passing through the interlayer insulating film;

wherein the interlayer insulating film is a first carbon-containing silicon oxide film (SiOC film); and

the inter-wiring insulating film comprises a laminated insulating film including an organic or inorganic low dielectric constant insulating film, and a multi-layer second carbon-containing silicon oxide film provided on the low dielectric constant insulating film and having a plurality of layers with different carbon contents, the

carbon content of the top layer of the second carbon-containing silicon oxide film being lower than that of the first carbon-containing silicon oxide film.

4. The semiconductor device according to claim 3, wherein the carbon content of the top layer of the second carbon-containing silicon oxide films is 3 atomic % to 9 atomic %.

5. The semiconductor device according to claim 1 or 3, wherein the lower buried-wiring layer is buried in the inter-wiring insulating film provided below the interlayer insulating film and comprising the organic insulating film and the carbon-containing silicon oxide film provided on the organic insulating film.

6. A method for manufacturing a semiconductor device having a wiring structure comprising a lower buried-wiring layer, an interlayer insulating film provided on the lower buried-wiring layer, an inter-wiring insulating film provided on the interlayer insulating film, and an upper buried-wiring layer buried in wiring grooves provided in the inter-wiring insulating film, the upper buried-wiring layer being electrically connected to the lower buried-wiring layer through contact plugs passing through the interlayer

insulating film;

wherein a method for forming the wiring structure comprises the steps of:

(1) depositing a first insulating film as the interlayer insulating film on the lower wiring;

(2) successively depositing a second insulating film and a first mask forming layer functioning as a third insulating film and for forming a first mask to form a laminated film functioning as the inter-wiring insulating film of the upper wiring, and depositing second and third mask forming layers for forming second mask and third mask, respectively;

(3) patterning the third mask forming layer to form the third mask having a wiring groove pattern;

(4) forming a resist mask having a connecting hole pattern on the second mask forming layer including the third mask;

(5) etching the third mask, the second mask forming layer, and the first mask forming layer functioning as the third insulating film through the resist mask, and further etching the second insulating film to form connecting holes;

(6) etching the second mask forming layer through the third mask to form the second mask having a wiring groove pattern, and digging down the connecting holes to an intermediate portion of the first insulating film;

(7) etching the first mask forming layer functioning as the third insulating film through the second mask to form a first mask having a wiring groove pattern, and further etching the first insulating film remaining at the bottoms of the connecting holes to form connecting holes;

(8) etching the second insulating film through the first mask to form wiring grooves in the second insulating film; and

(9) removing the second and third masks; and

the first mask forming layer functioning as the third insulating film comprises a carbon-containing silicon oxide film (SiOC film).

7. The method for manufacturing the semiconductor device according to claim 6, wherein in step (2), an inorganic insulating film including a carbon-containing silicon oxide film having a carbon content of 3 atomic % to 9 atomic % is deposited as the first mask forming layer functioning as the third insulating film.

8. The method for manufacturing the semiconductor device according to claim 6, wherein in step (2), a carbon-containing silicon oxide film comprising a plurality of layers having different carbon content may be deposited as the first mask forming layer functioning as the third

insulating film, the carbon content of the top layer of the carbon-containing silicon film being 3 atomic % to 9 atomic %.

9. The method for manufacturing the semiconductor device according to any one of claims 6 to 8, wherein a carbon-containing silicon oxide film is deposited as the first insulating film in step (1), and an organic insulating film is deposited as the second insulating film in step (2).

10. The method for manufacturing the semiconductor device according to claim 6, wherein in step (2), the first, second and third mask forming layers are deposited by using materials which permit etching of a lower mask forming layer by a reactive ion etching process using a mask formed in an upper mask forming layer.

11. The method for manufacturing the semiconductor device according to claim 10, wherein in step (2), a silicon nitride film (SiN film) and a silicon oxide film (SiO₂ film) are deposited as the second mask forming layer and the third mask forming layer, respectively.

12. The method for manufacturing the semiconductor device according to claim 6, wherein in step (2), each of

the first mask forming layer functioning as the third insulating film and the second and third mask forming layers is deposited by using a light-transmitting material.

13. The method for manufacturing the semiconductor device according to claim 6, wherein in step (4) of forming the resist mask having the connecting hole pattern on the second mask forming layer including the third mask, the resist mask is formed so that at least a portion of the connecting hole pattern overlaps with the wiring groove pattern of the third mask.

14. The method for manufacturing the semiconductor device according to any one of claims 6 to 12, wherein in forming the lower wiring, the organic insulating film and the first carbon-containing silicon oxide film (SiOC film) are deposited to form a laminated insulating film on the underlying layer, and then the lower buried wiring layer is buried in the laminated insulating film.